Amendments to the Drawings

The attached sheet of drawings includes changes to figure 4c. This sheet, which includes Figures 4a and 4b, replaces the original sheet including Figures 4a and 4b. In figure 4c, a previous typographical error has been corrected. Specifically, element 424 previously stated "Update Current Threaid," but has been corrected to state "Update Current Thread."

Attachment: Replacement Sheet

Remarks

In the office action, the Examiner rejected claims 1-36. More specifically:

- Claims 1, 2, 6, and 10-12 over Borkenhagen in view of Torii;
- Claims 3-4, 13, and 15 over Borkenhagen in view of Torii in further view of Proskauer
- Claims 5 and 14 over Borkenhagen in view of Torii in further view of Akkary
- Claims 7 and 16 over Borkenhagen in view of Torii in further view of Parady;
- Claims 8 and 17 over Borkenhagen in view of Torii in further view of Parady in further view of Penkovski;
- Claim 9 over Borkenhagen in view of Torii and in further view of Andrews;
- Claims 18-21 over Rodriguez in view of Borkenhagen;
- Claim 22 over Rodriguez in view of Borkenhagen in further view of Proskauer;
- Claim 23 over Rodriguez in view of Borkenhagen in further view Parady;
- Claims 24-27, 30-33, and 36 over Rodiguez in view of Borkenhagen in further view of Davis;
- Claims 28 and 34 over Rodriguez in view of Borkenhagen in further view of Davis in further view of Proskauer;
- Claims 29 and 35 over Rodriguez in view of Borkenhagen in view of Davis in further view of Parady.

In this response, claims 1, 11, 18, 24, and 30 have been amended to include features not taught by the cited references. No new matter has been presented. Claims 1-36 remain pending.

The Examiner also objected to the drawings and the specification. The Applicant has addressed each of these objections, in turn, below.

Drawings

In the Office Action, the Examiner objected to the drawings because Figure 4c included a spelling error. Corrected drawing sheets in compliance with 37 C.F.R. § 1.121(d) are provided with this office action response. Therefore, the Applicant respectfully requests the Examiner withdraw their objection to the drawings.

Specification

In the Office Action, the Examiner objected to the disclosure because the co-pending application number on page 11 was not provided. The Applicant has amended the specification to include the co-pending application number required by the Examiner. Therefore, the Applicant respectfully requests the Examiner withdraw their objection to the disclosure.

Claim Rejections

Claims 1, 2, 6, 10-12

In the Office Action, The Examiner rejected claims 1, 2, 6, and 10-12, under 35 U.S.C. § 103(a) as being unpatentable over Borkenhagen et al. (US 6,567,839) ("Borkenhagen") in view of Torii (US 5,913,059) ("Torii"). Applicant respectfully traverses these rejections.

Claim 1, currently recites,

1. A processing block comprising:
a storage sub-block;
an execution sub-block to execute instructions; and
a thread management sub-block coupled to the storage and execution sub-blocks, and equipped to store and maintain a thread switching structure in the storage sub-block to facilitate interleaving execution of a plurality of threads of instructions by the execution sub-block, with the thread switching structure including a current thread identifier identifying one of the plurality of threads as a current thread being currently executed by the execution sub-block, and a thread array of thread entries, one per thread, correspondingly describing the plurality of threads, each thread entry being created and added to the thread array by the thread management sub-block as part of the execution of a create thread instruction of a thread to spawn execution of another thread.

As required by the features of claim 1, a thread management sub-block must be equipped to store and maintain a thread switching structure in a storage sub-block, the thread switching structure including a thread array of thread entries, among other things.

The Examiner has relied on Borkenhagen to teach these features. The Examiner, however, has relied on individual elements within Borkenhagen which cannot fit into the structure required by claim 1. This structure is a significant feature of the Application as it allows for light weight interleaving of threads, and the ability to generate macro-blocks from the individual processing blocks.

In the Office Action, the Examiner equates the main memory, the L2, and L1 caches of Borkenhagen with the storage sub-block; the thread switch controller with the thread management sub-block; the thread switching structure with the collection of bits within the thread state register; and the thread array of thread entries with the thread state registers. A

careful analysis of the equivalent elements of Borkenhagen illustrates that they could not function as required by claim 1.

Most significant of these elements is the thread management sub-block. In the instant application, the thread management sub-block, in addition to other things, is required to store and maintain the thread switching structure in the storage sub-block, and create and add thread entries to the thread array as part of the execution of a create thread instruction.

The thread switch controller of Borkenhagen is incapable of accomplishing any of these features. Rather, Borkenhagen teaches the thread switch controller merely as "a myriad of logic gates which represents the culmination of all logic which actually determines whether a thread is switched, what thread, and under what circumstances." *Borkenhagen*, c.13 ll.17-19. In more detail, Borkenhagen teaches a thread switch control register to control events that will trigger a thread switch. These events are fed to the thread switch controller along with the varying states of a thread from the thread state registers. If the bits from the state registers suggest an event which corresponds with an event from the control register, the thread switch controller triggers a thread switch. There is simply no teaching in Borkenhagen that the thread switch controller ever stores or maintains the bits in the thread state registers, which the Examiner has equated with the thread switching structure. Rather, the states of the threads are populated from the instruction unit and the storage control unit of Borkenhagen.

Additionally, it is noted that the thread switch controller of Borkenhagen also fails to store the bits of the thread state registers in the main memory, L1, and L2 caches as would be required by the claims. Furthermore, the Examiner has equated the thread switching structure and the thread array with the bits of the thread register and the thread register itself, respectively. It is noted that neither of elements of Borkenhagen are stored in the storage sub-block. In fact, Borkenhagen teaches the thread state registers as being hardware and therefore, they are incapable of being stored and maintained in the storage sub-block.

Furthermore, the thread switch controller is never taught as creating and adding thread entries to the thread array in response to a create thread instruction. While the Applicant understands the Examiner has relied on Torii for the disclosure of "creating a thread," the combination of Borkenhagen and Torii would still require the thread switch controller of

Borkenhagen (i.e., the thread switching structure) to create a thread entry in the thread array. The thread switch controller, as stated previously however, lacks this ability.

In regard to Torii, it is respectfully submitted that Torii fails to cure these deficiencies. The Examiner has relied on Torii for the sole purpose of illustrating a "fork" command which generates a child thread. Therefore, it is respectfully submitted that the combination of Borkenhagen and Torii fail to disclose all the elements as required by claim 1.

For at lease these reasons, the references fail to make claim 1 obvious. Independent claim 11 includes similar limitations to that of claim 1, and is therefore, patentably distinct from the combination of Borkenhagen and Torii for at least the reasons given above. Claims 2, 6, 10, and 12 depend either directly or indirectly from claims 1 and 11 thereby incorporating their features. Therefore for the same reasons that claims 1 and 11 are allowable, claims 2, 6, 11, and 12 are similarly allowable.

In addition to their dependence from claims 1 and 11, claims 2 and 12 are independently allowable. Claims 2 and 12 include the feature "wherein each thread entry comprises a thread program counter to identify an instruction of the corresponding described thread as a current instruction to be executed when the corresponding described thread is being executed." The Examiner contends that it would have been obvious to a person of skill in the art at the time of invention that a thread program counter is implicit in the system of Borkenhagen. Such a statement, however, fails to address the claim as a whole. The Applicant respectfully submits that the true issue is whether it would have been obvious to one of ordinary skill in the art to include a program counter within the state register of Borkenhagen, which the Examiner has equated with the thread array. Given this statement, the Applicant respectfully disagrees that it would have been obvious. It is well known that state registers store only state information, and not program counters which identify instructions. This sentiment is mirrored even in Borkenhagen, "[t]hread state registers comprise a state register for each thread, and as the name suggests, store the state of the corresponding thread …." *Borkenhagen*, c.13 ll.23-25. Therefore, for at least this additional reason, claims 2 and 12 are allowable over the combination of Borkenhagen and Torii.

Claims 3-4, 13, and 15

Claims 3-4, 13, and 15 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Borkenhagen and Torii in view of Proskauer.

Claims 3-4, 13, and 15 depend, directly or indirectly, on claims 1 or 11. As discussed above, the combination of Borkenhagen and Torii fails to make claims 1 and 11 obvious. Proskauer fails to correct for the underlying deficiencies of the Borkenhagen/Torii combination.

Proskauer discusses a system in which a test computer sends a control signal to the capture instrument to retrieve data using various threads. Proskauer discloses that these threads may be executed simultaneously, assuming there are a sufficient number of processors, and that multiple thread information structures may be created to control the threads. Within the thread information structure there may be a thread active flag. Proskauer fails to disclose, however, anything resembling the various elements of independent claims 1 and 11. Therefore, it cannot cure the deficiencies of Borkenhagen and Torii.

For at least this reason, claims 3-4, 13, and 15 are patentable over the combination of Borkenhagen, Torii, and Proskauer.

Claims 5 and 14

Claims 5 and 14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Borkenhagen in view Torii, and in further view of Akkary.

Claims 5 and 14 depend, directly or indirectly, on claims 1 and 11, respectively. As discussed above, the combination of Borkenhagen and Torii fails to make claims 1 and 11 obvious. Akkary fails to correct for the underlying deficiencies of the Borkenhagen/Torii combination.

Akkary discusses multi-threading processors that have the ability to concurrently execute different threads from the same program where there may be dependencies among the threads. Akkary, however, fails to disclose the thread switching structure, and sub-blocks of independent claims 1 and 11. Therefore it also fails to cure the deficiencies of Borkenhagen and Torii. For at least this reason, claims 5 and 14 are patentable over the combination of Borkenhagen, Torii, and Akkary.

Claims 7 and 16

Claims 7 and 16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Borkenhagen in view of Torii, and in further view of Parady.

Claims 7 and 16 depend, directly or indirectly, on claims 1 or 11. As discussed above, the combination of Borkenhagen and Torii fails to make claims 1 and 11 obvious. Parady fails to correct for the underlying deficiencies of the Borkenhagen/Torii combination.

Parady discusses a method and apparatus for switching between threads of a program in response to a long-latency event. The thread switching logic is configured to switch execution to an address in a program address register in response to a designated instruction type. Parady discloses, however, that the thread switching logic is merely provided to give a hardware thread-switching capability. *Parady*, c.3 ll.57-60. It, like Borkenhagen, fails to provide a thread management sub-block that may store and maintain a thread switching structure. Therefore, it fails to cure the deficiencies of the Borkenhagen/Torii combination. For at least this reason, claims 7 and 16 are allowable over the combination of Borkenhagen, Torii, and Parady.

Claims 8 and 17

Claims 8 and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Borkenhagen in view of Torii and Parady, and in further view of Penkovski.

Claims 8 and 17 depend, directly or indirectly, on claims 1 or 11. As discussed above, the combination of Borkenhagen , Torii, and Parady fails to make claims 1, 11, 7, or 16 obvious. Penkovski fails to correct for the underlying deficiencies of the Borkenhagen/Torii/Parady combination.

Penkovski is cited by the Examiner for teaching the execution sub-block is equipped to select the next current thread based on chosen priority rules. The Applicant contends that this is as far as the similarities of Penkovski extend. Penkovski also fails to teach the essential structure of independent claims 1 and 11 and therefore fails to cure any of the deficiencies of Borkenhagen, Torii, or even Parady. Therefore, for at least this reason claims 8 and 17 are allowable over the combination of Borkenhagen, Torii, Parady, and Penkovski.

Claim 9

Claim 9 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Borkenhagen in view of Torii and in further view of Andrews.

Claim 9 depends either directly or indirectly from claim 1. As discussed above, the combination of Borkenhagen and Torii fail to make claim 1 obvious. Andrews fails to correct the deficiencies of the Borkenhagen/Torii combination. For at least this reason, claim 9 is allowable over the combination of Borkenhagen, Torii, and Andrews.

Claims 18-21

Claims 18-21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Rodriguez in view of Borkenhagen.

Claim 18, as amended, now includes similar features to that of claim 1. Specifically, Claim 18 currently recites:

18. A signal processing macroblock comprising:
a set of registers; and
at least a selected one of
an input processing block coupled to the set of registers, including:
an input interface; and
execution and thread management facilities equipped to support interleaved execution of multiple threads of instructions, the thread management facilities including a thread management sub-block equipped to maintain a thread switching structure and create and add thread entries corresponding to the multiple threads of instructions to a thread array within the thread switching structure; and
an output processing block coupled to the set of registers, including an output interface, execution and thread management facilities equipped to support interleaved execution of multiple threads of instructions, the thread management facilities including a thread management sub-block equipped to maintain a thread switching structure and create and add thread entries corresponding to the multiple threads of instructions to a thread array within the thread switching structure.

In the Office Action, the Examiner concedes that Rodriguez does not disclose "that input and output processing blocks include execution and thread management facilities equipped to support interleaved execution of multiple threads of instructions." *Office Action*, p.15 n.43. Rather, the Examiner relies on Borkenhagen for such a teaching. While Borkenhagen may

arguably teach intput and output processing blocks as previously claimed, the Applicant submits that the amendments which include similar features of claim 1 are not taught by Borkenhagen for the reasons discussed with reference to Claim 1. Therefore, because Rodriquez does not teach processing blocks, and the Borkenhagen fails to teach various elements of the processing block as claimed, the combination of Borkenhagen and Rodriguez fails to teach each and every element of the claim. Therefore, the combination does not render claim 18 obvious. For at least this reason claim 18 is allowable.

Claims 19-21 depend either directly or indirectly from claim 18, thereby incorporating its features. Therefore, for at least the same reasons that claim 18 is allowable, claims 19 and 20 are similarly allowable.

Claim 22

Claim 22 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Rodriguez in view of Borkenhagen, and in further view of Proskauer.

Claim 22 depends, directly or indirectly, on claims 18. As discussed above, the combination of Rodriguez and Borkenhagen fails to make claims 18 obvious. Proskauer fails to correct for the underlying deficiencies of the Rodriguez/Borkenhagen combination.

Proskauer is discussed in more detail previously, but in summary, Proskauer fails to disclose a processing block including a thread management sub-block. Therefore, Proskauer fails to cure any of the deficiencies of Rodriguez and Borkenhagen. For at least this reason, Claim 22 is allowable over the combination of Rodriguez, Borkenhagen, and Proskauer.

Claim 23

Claim 23 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Rodriguez in view of Borkenhagen, and in further view of Parady.

Claim 23 depends, directly or indirectly, on claims 18. As discussed above, the combination of Rodriguez and Borkenhagen fails to make claims 18 obvious. Parady fails to correct for the underlying deficiencies of the Rodriguez/Borkenhagen combination.

Parady is discussed in more detail in the response pertaining to claims 7 and 16. It, like Borkenhagen, fails to provide a thread management sub-block that may store and maintain a

thread switching. As stated previously, the Examiner has conceded that Rodriguez fails to teach thread management facilities. Because neither Parady, Borkenhagen, nor Rodriguez teach all the elements of claim 23, claim 23 is in allowable form.

Claims 24-27, and 30-33, and 36

Claims 24-27, and 30-33, and 36 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Rodriguez in view of Borkenhagen and further in view of Davis.

Independent claims 24 and 30 have been amended to include features similar to that of claim 18, 11, and 1. Specifically, they have been amended to include the feature that "the thread management facilities including a thread management sub-block equipped to maintain a thread switching structure, and create and add thread entries corresponding to the multiple threads of instructions to a thread array within the thread switching structure."

In the Office Action, the Examiner has relied on Borkenhagen to disclose the thread management facilities. In doing so, the Examiner has conceded that Rodriguez fails to teach thread management facilities equipped to support interleaved execution of multiple threads of instruction. The Examiner relies on Davis merely for the teaching "a plurality of signal processing units coupled to the direct memory access unit." *Office Action,* p.23 n.70. Davis, however, does not cure the deficiencies of both Borkenhagen and Rodriguez which have been discussed at length above. Therefore, the combination of Rodriguez, Borkenhagen, and Davis fail to teach all the features of independent claims 24 and 30. For at least this reason, claims 24 and 30 are allowable.

Claims 25-27, 31-33, and 36, all depend either directly or indirectly on independent claims 24 and 30 thereby incorporating their limitations. Therefore, for at least the same reason that claims 24 and 30 are allowable claims 25-27, 31-33, and 36 are also allowable.

Claim 28 and 34

Claims 28 and 34 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Rodriguez in view of Borkenhagen, and Davis, and in further view of Proskauer.

Claims 28 and 34 depend, directly or indirectly, from independent claims 24 and 30, respectively. As has been discussed previously with respect to the combination of references

including Rodriguez, Borkenhagen, and Davis, all the references in combination fail to teach all the features of the independent claims. Furthermore, it is noted that Proskauer also fails to cure this deficiency. Proskauer is merely relied on for the disclosure of an execution sub-block equipped to reset an activeness indicator of a thread entry in a thread array. Proskauer, however, does not disclose a thread management sub-block as recited in the claims. Therefore, the combination of Rodriguez, Borkenhagen, Davis, and Proskauer fail to teach each and every element as recited in the claims. Therefore, the combination fails fails to render claims 28 and 34 obvious. For at least this reason the claims 28 and 34 are allowable.

Claims 29 and 35

Claims 29 and 35 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Rodriguez in view of Borkenhagen, and Davis, and in further view of Parady.

Claims 29 and 35 depend either directly or indirectly from independent claims 24 and 30 thereby incorporating their limitations. As discussed above, the combination of Rodriguez, Borkenhagen, and Davis fail to teach every element of the independent claims. Parady also fails to cure this deficiency. Therefore, the combination of Rodriquez, Borkenhagen, Davis, and Parady all fail to render claims 29 and 35 obvious. For at least this reason claims 29 and 35 are allowable.

Conclusion

Claims 1-36 remain pending, no claims have been added or cancelled. As set forth above, Applicants submit that these claims are allowable and thus respectfully request allowance of the same. If the examiner has any questions regarding the substance of this office action response, he is invited to contact the undersigned at 503-796-2408.

The Commissioner is hereby authorized to charge shortages or credit overpayments to Deposit Account No. 500393.

Respectfully submitted,

SCHWABE, WILLIAMSON & WYATT, P.C.

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/Rob McDowell/

Robert D. McDowell
Reg. No. 59,062

Pacwest Center, Suite 1900
1211 SW Fifth Avenue
Portland, Oregon 97204
Telephone: 503-222-9981